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Method and system of speed limitation with distance control for a motor vehicle

The present invention relates to a method of limitation  
5 of speed for a motor vehicle with distance control with  
respect to the vehicle in front in the same traffic  
lane. This system helps the driver to comply with a  
speed limitation and/or a following time behind the  
10 the distance separating the two vehicles to the speed  
of the vehicle equipped with the system. It also  
relates to a system for implementing this method.

There currently exist systems for limiting the speed of  
15 a vehicle to a value fixed by the driver, intended to  
prevent the driver from exceeding a preset limit value  
which he has chosen, save through a deliberate special  
maneuver.

20 Such a speed limiting system comprises in particular an  
accelerator pedal, or any engine power control member  
maneuverable by the driver, making it possible to  
accelerate the vehicle. It moreover comprises means  
giving the pedal a first active travel and then a  
25 second dead travel up to a hard point, which is  
manifested as a fixed point of the stroke of the pedal,  
irrespective of the limit speed chosen.

The information regarding the position of the  
30 accelerator pedal is transformed into a signal of  
request of acceleration on the part of the driver that  
an electronic computer will compare with an  
acceleration request signal due to the speed regulation  
and calculated as a function of the difference between  
35 the actual speed of the vehicle and the preset speed.  
Comparison between these two acceleration request  
signals, due to speed regulation on the one hand and

due to the pedal on the other hand, makes it possible to determine a vehicle acceleration control signal.

An exemplary embodiment of a speed limiter is described in the patent application published as No. FR 2 755 650, in the name of RENAULT. In this example, the pedal comprises a dead travel between a first active travel and a hard point, and this hard point manifests itself as a fixed point of the stroke of the pedal, irrespective of the limit speed chosen.

The speed limiter limits the torque of the engine of the vehicle, so as to prevent the exceeding of a limit speed fixed by the driver, without action on the braking system. As long as this limit value is not reached, the relation which rereads the position of the accelerator pedal to the engine torque is identical to that which exists when the limiter is inactive, that is to say that depressing the pedal increases the acceleration and that lifting the foot causes a deceleration, but when the preset limit speed is reached, the engine torque is limited to a value which does not allow the vehicle to exceed this speed. Any further pressing of the pedal beyond this reference position has no effect on the torque value and hence on the speed of the vehicle, and corresponds to a dead travel or zone of the pedal.

On the other hand, any relaxation of the accelerator pedal short of this reference position, fixing the preset speed of the vehicle, permits a deceleration of the vehicle since the relation between the engine torque and the position of the pedal is again valid.

When the vehicle equipped with the speed limiter is approaching a vehicle that is slower than it, in order to reduce its speed, the driver will have to act on the

accelerator pedal by lifting his foot or else on the brake pedal by depressing it.

On the other hand there exist speed regulator systems with distance control - Adaptive Cruise Control - ACC, which control the power of the engine and the brakes of the vehicle with the aim of:

- regulating the speed of the equipped vehicle to a constant value without intervention of the driver on the accelerator pedal;
- adjusting the speed of the vehicle to a value equal to that of the vehicle in front, traveling more slowly in the same traffic lane;
- maintaining a constant following time with the vehicle in front with a lower speed, in the same traffic lane.

To reduce the acceleration determined automatically by the system, the driver must press the brake pedal or else act on a button placed on the steering wheel or on the dashboard, these two actions having the effect of deactivating the speed regulation system with distance control. The acceleration may also be reduced by action of the driver on the preset speed member, not always well suited to all types of situations. In particular, certain complex road situations are poorly managed by the telemetry carried on board the vehicle, possibly causing uncomfortable re-accelerations of the vehicle due to momentary loss of detection of the vehicles in the lane, on bends for example.

The aim of the invention is to alleviate the drawbacks of these two types of systems described above, that is to say having to brake in speed limitation, in the approach phase, on the one hand, and deactivate the speed regulation in order to reduce the acceleration on the other hand.

To do this, a first subject of the invention is a method of speed limitation with distance control for a motor vehicle equipped with telemetry means intended to  
5 estimate the distance and the speed of the vehicles traveling in the same traffic lane as the vehicle, and means of slaving of the operation of the engine speed-wise and distance-wise, characterized in that it carries out the following steps:

- 10       -a) activation of the method;
- b) choice of a speed preset;
- c) verification of the absence of a slower target vehicle in the same traffic lane, and if so:
- e) limitation of the engine torque by action of  
15 the driver on the acceleration pedal as long as the vehicle speed is below the preset speed and by automatic control when the preset speed is reached or exceeded, with possibility of deactivation of the method;
- 20       -d) verification of the presence of a slower target vehicle in front of the equipped vehicle in the same traffic lane, and if so:
- f) automatic reduction of the speed and maintaining of a constant following time between  
25 the two vehicles, which can be adjusted by the driver;
- g) reduction, permitted to the driver, of the speed determined by the method, by lifting of the foot on the accelerator pedal or pressing the  
30 brake without deactivating the method of speed limitation;
- h) verification of the speed of the target vehicle, and in case of increase beyond the preset speed, possibility of acceleration for the driver  
35 of the equipped vehicle up to the speed preset or distance preset if the target vehicle is caught up with again.

A second subject of the invention is a system for implementing said method of limitation of speed with distance control for a motor vehicle, comprising first telemetry means intended to estimate the distance and the speed of the vehicles traveling in the same traffic lane as the equipped vehicle, and second means of slaving of the operation of the engine speed-wise and distance-wise, receiving as input a speed preset and a following time preset and delivering a vehicle acceleration and braking command, characterized in that it comprises moreover:

- third means of reconstruction of the braking request of the driver, intended to deliver a signal homogeneous with the braking command delivered by the aforesaid slaving means;
- fourth means of reconstruction of the acceleration request of the driver, intended to deliver a signal homogeneous with the acceleration command delivered by the aforesaid slaving means;
- fifth means of arbitration between the braking signal requested by the driver and the braking command by calculation of the maximum value between these two braking values;
- sixth means of arbitration between the acceleration signal requested by the driver and the acceleration command by calculation of the minimum value between these two acceleration values;
- seventh means of arbitration between the control of the braking and that of the acceleration by priority choice of braking over acceleration, delivering control signals to the braking member of the vehicle and to the engine.

Other characteristics and advantages of the invention will become apparent on reading the description illustrated by the following figures:

- 5     -     figure 1: a method of speed limitation with distance control of a vehicle according to the invention;
- figure 2: an example of a system for implementing  
10     the method of speed limitation with distance control according to the invention.

The invention is intended for limiting the speed of the vehicle equipped with the system while yet controlling  
15     its distance with respect to the vehicle in front in the same traffic lane, while the driver keeps his foot on the accelerator pedal or presses the brake pedal without deactivating the system.

20     When the driver has triggered the activation of the method, in step a), and fixed a speed preset in step b), if the absence of any slower target vehicle in the traffic lane is verified, that is to say either in the absence of any vehicle noted in step c), or in the  
25     presence of a faster vehicle, noted in step d), the method carries out the conventional speed limitation function, (step e), which limits the engine torque so as not to exceed the preset speed that the driver himself has fixed. For vehicle speed values below the  
30     preset, the position of the accelerator pedal imposed by the driver corresponds to a given acceleration, and for speed values above the preset, the system automatically limits the engine torque. To this limit value of torque there corresponds a reference position  
35     of the accelerator pedal, beyond which any further depression has no effect.

In the presence of a slower vehicle in front of the equipped vehicle traveling at the preset speed and called the target, noted in step d), the method automatically reduces the speed of the equipped vehicle without the driver having to lift his foot from the accelerator pedal or resume control of the vehicle, and maintains a following time between these two vehicles which is constant and the value of which can be adjusted by the driver (step f).

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However, at any moment the driver can himself reduce this speed determined automatically by the system, by acting on the accelerator pedal by lifting his foot, or by depressing the brake pedal, without causing the deactivation of the system (step g).

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If the distance between the two vehicles increases, that is to say if the speed of the target vehicle of the lane detected in step h) increases, the driver can again re-accelerate until the speed preset or distance preset is reached if the vehicle followed is caught up with again.

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To carry out these steps as a function of the presence or of the absence, on the same traffic lane, of any vehicle slower than the equipped vehicle, the vehicle is equipped with an implementation system which comprises the following various elements.

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To begin with, it is equipped with first means of estimation of the distance and of speed of the vehicles traveling in the same traffic lane, such as a telemeter, a radar or a lidar for example. The telemetry means 1 deliver information  $I_{Dv}$  regarding the distance and the speed of the vehicles traveling in the same lane as the vehicle, ahead of it. This information is dispatched to second means 2 of slaving of the operation of the engine speed-wise and distance-wise,

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which additionally receive as input a speed preset  $C_v$  and a distance preset  $C_d$ . These slaving means deliver an acceleration command  $C_A$  or braking command  $C_F$  to the relevant members of the vehicle, either the engine M or  
5 the braking system F.

The system according to the invention moreover comprises third means 3 of reconstruction of the braking request of the driver, this being manifested as  
10 a pressing force on the brake pedal. This request must be homogeneous with the braking request delivered by the slaving means 2, which may be a pressure in the braking circuit, a deceleration torque or a flow rate of fuel for example. The means 3 transform the pressing  
15 force  $P_F$  on the brake pedal into a quantity homogeneous with the braking command and deliver a signal  $S_F$  homogeneous with the braking command  $C_F$ , these two signals ending up as input to fourth means 4 of arbitrating between them. The means 4 arbitrate between  
20 these two braking requests by determining the maximum  $F_M$  between these two values  $S_F$  and  $C_F$ , so that the stronger request is taken into account, be it the automatic command or the request of the driver, to control the braking.

25 Concerning the driver acceleration request which is manifested as a pressing force  $P_A$  on the acceleration pedal, it must be rendered homogeneous with the acceleration command  $C_A$  delivered by the means 2 of  
30 slaving of the engine so as to be compared with it. To do this fifth means 5 of reconstruction of this request transform it into a quantity  $S_A$  homogeneous with the acceleration command  $C_A$ , which may for example be a torque request. The two homogeneous acceleration  
35 signals  $S_A$  and  $C_A$  end up as input to sixth means 6 of arbitrating between them, by determining the minimum between these two values so that the weaker request  $A_m$



is taken into account to control the acceleration of the vehicle.

The system finally comprises seventh means 7 of  
5 arbitrating between the control of the braking F and  
the control of the acceleration of the vehicle M, by  
choosing in the nominal mode to always favor braking  
over acceleration. Thus, if the driver or the speed  
10 limitation system simultaneously requests braking and  
acceleration, it is the deceleration preset which will  
be dispatched to the braking member.

If the system has in addition a device offering the  
driver the possibility of resuming control, by way of a  
15 device such as a mechanical hard point at the extremity  
of the travel of the accelerator pedal, otherwise known  
as a 'kick down' for example, and should the driver  
actuate this device deliberately, priority is then  
given to the braking or acceleration requests of the  
20 driver over the requests of the speed limitation  
system.